Torii, Ryo; **Oshima, Marie**; **Kobayashi, Toshio**; **Takagi, Kiyoshi**; **Tezduyar, Tayfun E.**
Computer modeling of cardiovascular fluid-structure interactions with the deforming-spatial-domain/stabilized space-time formulation. (English) Zbl 1178.76241
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Summary: Hemodynamic factors such as the wall shear stress are believed to affect a number of cardiovascular diseases including atherosclerosis and aneurysm. Since resolving phenomena in a living human body is currently beyond the capabilities of in vivo measurement techniques, computer modeling is expected to play an important role in gaining a better understanding of the relationship between the cardiovascular diseases and the hemodynamic factors. We have developed a computer modeling technique for cardiovascular hemodynamic simulations. With this modeling technique, patient-specific 3D geometry of an artery can be analyzed. We take into account some of the important factors in human body for the purpose of demonstrating in vivo situations in a virtual world. The interaction between the blood flow and the deformation of the arterial walls is a factor that we are specifically focusing on. For such fluid-structure interactions, we have developed a computer modeling tool based on the deforming-spatial-domain/stabilized space-time (DSD/SST) formulation. This simulation tool is applied to a patient-specific model under pulsatile blood flow conditions. The simulations show that the flow behavior with compliant arterial walls is different from what we see with rigid arterial walls. Consequently, the distribution of the wall shear stress on the compliant arterial walls is significantly different from that on the rigid arterial walls. We deduce that the compliance of the arterial walls needs to be taken into account in cardiovascular hemodynamic simulations, and the computer modeling tool we have developed can be effective in investigation of cardiovascular diseases.

MSC:

76M10	Finite element methods applied to problems in fluid mechanics
76Z05	Physiological flows
76D05	Navier-Stokes equations for incompressible viscous fluids
74F10	Fluid-solid interactions (including aero- and hydro-elasticity, porosity, etc.)
92C10	Biomechanics
92-08	Computational methods for problems pertaining to biology

Keywords:

cardiovascular disease; fluid-structure interaction; DSD/SST method

Full Text: DOI

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